Perhaps the most interesting application of the 100-in. telescope hitherto made is that rendered possible by the utilisation of Michelson's interference method for the measurement of the spectroscopic binary star Capella. The method consists in completely covering the 100-in. mirror by a screen in which are two slits, which can be placed at any desired distance apart. Light coming from a point source, such as a single star at a very great distance from the earth, passes through the two slits and is brought to focus by the large mirror. A system of interference fringes may then be seen under a telescopic power of about 5000 diameters, which are sharply defined even on a night of poor seeing. If the star is single, the fringes remain visible even when the slits are separated by the full diameter of the 100 in. mirror. But if the star is a very close double, the fringes will disappear (assuming the members of the pair to be nearly equal in brightness) when the slits, set by observation at the proper position angle, are moved apart to a distance that depends upon the angular distance between the star's components.[1]

The following measures of Capella, made by Dr. Anderson, indicate the possibilities of the method:

	Position angle °	Distance ″
1919, December 30 ...	148·0	0·0418
1920, February 13 ...	5·0	0·0458
" " 14 ...	1·0	0·0451
" " 15 ...	356·4	0·0443
" March 15 ...	242·0	0·0505

1 In practice, a somewhat different technique, giving the same result with higher precision, is employed by Dr. Anderson.

When plotted, these points fall accurately on an ellipse. The method, which has been tested experimentally in the laboratory, not only allows binaries that cannot be resolved by other means to be measured with very high precision, but also permits *twice* the theoretical resolving power of the Hooker telescope to be attained in practice, even when the seeing is poor.

This application of the interferometer was suggested by Prof. Michelson many years ago and used by him in the measurement of the diameter of Jupiter's satellites at the Lick Observatory in 1891. The possibility of seeing the fringes under ordinary atmospheric conditions with the full aperture of the Hooker telescope was demonstrated by Prof. Michelson during a visit to Mount Wilson last September. The method will have many applications, and should be utilised by observers with instruments of moderate aperture who wish to resolve close doubles and to increase greatly the precision of their measures.[2]

From this record of the preliminary tests of the Hooker telescope it will be seen that in light-collecting power, in the increased scale and improved photographic definition, and in the added possibilities of optical resolution attained through the application of Michelson's method, the new instrument has not disappointed our hopes. We must now endeavour to utilise these advantages in the extension and development of our researches on stellar evolution and the structure of the universe.

2 For an account of this method, see Michelson, "On the Application of Interference Methods to Astronomical Measurements," *Phil. Mag.*, July 1890.

Artillery Science.

By SIR GEORGE GREENHILL, F.R.S.

"THE religious attachment of the officer of artillery to the practice of his predecessors" was described by Benjamin Robins about 1740, and his attachment persisted with unimpaired devotion right up to the war. There he found himself outclassed at the outset, out-gunned and out-gunnered; the little artillery he took out was small and puny, and not of the right sort required—"pas de celle qu'il faut." Our Artillery Authority cannot be said to have understood what it spelt, the word "artillery."

On the assumption of our politicians that this country was never going to war again, an interdict had been laid on England of seven lean years; and when they were up, the lean years got an extension leading right up into the war.

A well-disciplined Army Council had been formed, obsequious to the Minister, with instructions to resist all suggestions of military progress—housed in a magnificent new palace in Whitehall, the barracks of an army of War Office clerks, provided out of a reduction of the Regular soldiers.

Temple of Victory it cannot be called. The stone slab over the portal is still blank, ready to receive the appropriate motto, with no derangement in the epitaph:

PACEM PARA BELLUM SI VIS.

The mentality of the Army Council can be glimpsed in its attitude to Flight in warfare. The Wright brothers framed on their wall the egregious answer of the Secretary in the official jargon: "I have nothing to add to my last letter to you. The War Office is not disposed to enter into relations with any manufacturers of airplanes."

This was in March, 1913, and only the next year we were running the risk of our whole Army being completely surrounded, with no airmen to scout for us. The evil name "Maubeuge" would have been written on our history as indelibly as "Jena" and "Sedan" were on others. No wonder the German squadrons could fly all over England and London with impunity, in the face of all our air defence.

The belated arrival in the war of the Tank is another similar story. Military prejudice preferred to muddle along in a stalemate of trench

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warfare, at a cost of two years' delay, of intolerable waste and slaughter, before it could be persuaded to take up this new revolutionary idea. The German advance walked over our trench warfare system in the spring of 1918, and took all our guns.

Technically bold as a lion, our military soul was intellectually a very timid bird, and shuddered at any suggestion of novelty and progress. Whenever I asked an artillery officer: "What did you learn as a cadet at the Royal Military Academy?" the answer came in the invariable formula: "I learnt nothing when I was at the Shop."

The Shop! Not a workshop, except so far as the "ca' canny" slogan would carry. And yet we find this nickname, full of meaning and contemptuous, is countenanced by authority, from the Governor downward, as a surrender of all Prestige. It should be made a crime of a military nature ever to use such a derisory, contemptuous *alias*, too descriptive of the obsolete, decadent traditions of the place.

The Army List gives a whole page to the catalogue of the staff of the Royal Military Academy, Woolwich, full of official Army titles. Low down on the page a line is to be seen, and under it a list of half a dozen names, the civilian instructors who should carry out the real work of the place.

Nothing was ever so Prussian, not even in Prussia. But the line has a more sinister meaning still; it emphasises one of the important reforms of the Cardwell scheme, and excludes all those appearing under it from retiring allowance, while every Civil Service clerk is *pukka*, subsidised and covenanted, on the strength of a Civil Service examination, medical or otherwise. A sailor would compare the Academy to a boat trimming too much by the stern, with too many cocked hats in the stern sheets.

This the only source of supply of our artillery officer does not run clear; it commissions him with the brand of second class, with all the mental outlook implied of indolence and apathy.

Thinking officers among them deplore the arrangement, and are beginning to confess to their deficiency of all artillery science in the war; but, with military docility, they are afraid to say much, and formerly, before the war, would bring upon themselves the scowl of the senior officer, and the disparaging epithet of "scientific."

The old school aimed at being as close an imitation of cavalry as possible, and a stable boy was the noblest gunner of them all, prepared to carry out a gallop of a few seconds over Woolwich Common, with a little gun on wheels behind. The idea was deprecated of firing off his gun, in imitation of the practice exacted in real warfare, as likely to wear the gun out, and so provided a good excuse.

But here is a Disadvantage of Durability, especially in artillery, and most of all in its traditions. Our guns were always obsolete when they were most wanted.

So this gunner preferred to seek the seclusion of his stable before the guns began to shoot; he was encouraged to be gun-shy, and to despise any sort of artillery that could not go at a gallop behind horses. His favourite arm was this *corps d'élite*, the plaything of the I.R.C. (Idle Rich Class), very expensive to maintain in peace, and of little proved utility in war commensurate with the cost.

But motor artillery has come to stay as the real artillery, unless "bilked" by the old school. This was the sort required in the war, and in peace it is not eating its head off, like horses in a stable, and is never tired on the march. De Wet was run to earth very soon by a squadron of motor-cars never giving his horses any rest: what our old cavalry tactics never could effect.

The civilian has grasped the paramount importance in modern warfare of heavy long-range artillery; and he must be careful that the lesson has not been lost on the regular gunner, or allow him to return to his ancient, worn-out traditions. Such long-range fire was declared officially of no military value, until our poor fellows came under the accurate fire of the long-range German howitzer, with no protection from our own side.

German science could always astonish our sleepy regular gunner, in providing a gun that could bombard Paris, and London too, when it could be brought up as near as Calais. How much longer would the war have lasted then? although the fire was declared of no military importance by those who did not suffer under it.

This advanced German artillery science, as well as of the chemical and aeronautical science, was the outcome and product of the Military Technical Academy in Berlin, a magnificent institution such as our Ministers thought England was too poor to afford. Sixty officers were under instruction there in a three years' course more thorough than exacted to-day for honours in the university. No wonder our feeble amateur military science went down before such superior training.

I was once privileged to visit the Berlin Academy, under the guidance of Prof. Cranz, and to inspect the instruction in all branches—ballistics, aeronautics, and electricity. There, for one thing, I remember seeing the electrical class occupied in making the antennæ of wireless telegraphy. This was ten years ago, when aeronautical science and flight were derided by our War Office authority, and opposed on the score of economy. We shall not feel safe in England until we set up a rival institution, but it must be as far apart as possible from the Woolwich tradition. South Kensington would be an ideal site, say in the building of the old School of Mines and Naval Architecture and alongside the Imperial College of Science, as the Berlin Academy is a neighbour of the Charlottenburg Technical High School, with the same

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advantage of the free use of laboratories and special professorial lectures. Our artillery will then be able to throw off the badge of second class and claim to take the rank of first class again.

A cadet military college can only carry on the initial stage of the education of the artillery officer, and for that it is better for him not to be isolated too early from the other military branches. Many a scheme for the amalgamation of the military colleges will be found pigeon-holed in the War Office, awaiting the pressure required to be exerted on the opportunist. The artillery could then make its selection from the whole list of Army candidates, and with proper prestige secure the pick of the bunch. It would not then have to submit, as at present, to put up with the leavings of the Royal Engineers, and to be branded as second class.

The pick of the officers, after some military service, would be selected for a further course at our equivalent of the Berlin Military Technical Academy, where neither indolence nor apathy was tolerated, but stigmatised as bad form, so I was informed. Here they would find a standard of university rank, in a centre of keen intellectual activity.

But the atmosphere of all Woolwich is close and ill-ventilated. Throw open the window, and let in air and light! The Royal Military Academy there is unhealthy, physically as well as mentally, seated on the safety-valve of the main drainage of all South London. The buildings are antiquated and worn-out, fit only to be mined and blown up at the moon, and then a more healthy atmosphere, physical and intellectual, might be formed. With the solidarity of any other trade union, Woolwich strongly opposed dilution. But Dilution proved the best material, and carried the war to a successful conclusion, and so the insidious efforts at his elimination in peace must be watched carefully, and countered by a plentiful entry of university candidates from the outside.

The country will never cease to shiver at the recollection of our narrow escape from defeat and utter ruin, and will listen to no specious political views of opportunist economy likely to place us again in a state of military inferiority.

Obituary.

DR. RUDOLPH MESSEL, F.R.S.

DR. R. MESSEL died on Sunday, April 18, in his seventy-third year. Death came to him as a happy release but to a large circle of friends familiar with his social qualities and many acts of unostentatious generosity the loss is severe and will be deeply mourned. He had long been one of the most notable of our chemical manufacturers as pioneer founder of a most important industry, for he was the first to produce sulphuric anhydride from its elements on a large scale.

Messel was born in Darmstadt and came to this country, at the conclusion of his university career, shortly before the Franco-Prussian War; when this broke out he returned to Germany and volunteered for service but owing to a physical disability, I believe, he was drafted into the Army Service Corps and was wounded while on ambulance duty. He lost no time in returning to England and became assistant to the late Dr. Squire, a man of considerable ability and originality. Messel had qualified at Tübingen as a chemist under Strecker, who naturally took an interest in the then infant alizarin industry, as he had worked with alizarin. Strecker foresaw the important part that fuming sulphuric acid was to play in the industry and directed Messel's attention to the fact, suggesting that he might well seek to supply the want. Messel, therefore, was fully conversant with what had been done and when Squire, possessed of the same idea as Strecker, suggested to his assistant that he should set to work on the subject, he was soon ready with a process, having at once resorted to the use of platinum as a catalyst in order to bring about the interaction of sulphur dioxide with atmospheric oxygen.

A patent was taken out by Squire in 1875 and he and Messel described their process in a paper read to the Chemical Society early in 1876; but this was not published. Their works were erected at Silvertown, on the Thames; the manufacturing process was rapidly developed through Messel's skill and intense devotion to his task. Not alone were English wants soon met but a considerable quantity of the acid was supplied to the German colour-makers. The Badische Anilin- & Soda-Fabrik was led largely to develop the manufacture of the acid in connection with the production of synthetic indigotin; but the "splash" this firm made in 1900, when it published the results of its experiments in considerable detail, was unwarranted. Practically everything essential then put forward had long been a matter of everyday practice with Messel. Had not commercial considerations prevailed, he might well have upset the patents; but he was ever a man of peace, as well as a modest man, so he made no attempt to claim the credit that was his due. He acquired the German patents at a peppercorn price but his former countrymen never had the honesty to do him public justice.

The writer was a frequent visitor at Silvertown in early days and was always impressed by the remarkably systematic manner in which the works were operated. Messel was ever on the look-out for improvements and ever ready to make them. His chief trial in later years was the difficulty he experienced in persuading his conservative British

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